

THE
BOTANICAL GAZETTE

APRIL 1918

CARDUACEOUS SPECIES OF PUCCINIA¹

I. SPECIES OCCURRING ON THE TRIBE VERNONIAE

H. S. JACKSON

This is the first of a proposed series of papers dealing with the species of *Puccinia* occurring on the Carduaceae. It is planned to discuss in separate articles the species recorded on the host genera included in the different tribes of the family. The series is the result of a study made in connection with the preparation, by the writer, of the manuscript of the species of *Puccinia* occurring on this family of hosts for *North American Flora*.

The number of species of *Puccinia* described from all parts of the world as occurring on members of the Carduaceae is very large, more than 300, and on account of the great variety of forms, and the close relationship and variability of the hosts which they inhabit, they offer a very interesting as well as difficult group for study by the uredinologist. In order to understand properly the forms occurring in North America, a study is being made so far as possible of all the described species. In order to bring together the present knowledge of the species occurring on closely related hosts, the forms recorded on the different tribes of the Carduaceae are being taken up separately.

Species of *Puccinia* are recorded on but three genera of the carduaceous tribe Vernoniae as limited by O. HOFFMANN in ENGLER and PRANTL'S *Die Pflanzenfamilien*; these are *Vernonia*, *Elephantopus*, and *Piptocarpha*. The two latter genera harbor 2 species

¹ Presented in part before the Botanical Society of America at Pittsburgh, January 1, 1918. Contribution from the Botanical Department of the Purdue University Agricultural Experiment Station.

each, while on the genus first mentioned 25 species are here recognized. All of the species, so far as known, are autoecious, although the full life history has been determined for only a few. There are a number of unconnected species of *Aecidium* and *Uredo* recorded which are not discussed in this account. While it is possible that some of the former may belong to heteroecious species, there is no supporting evidence available.

The large number of species occurring on *Vernonia* and the great variation in morphological characters and in life history which they exhibit are perhaps unparalleled on any other host genus in this group of rusts. When we consider, however, that the most important influencing factor in the evolution of the parasitic fungi, particularly in a group as highly specialized as the rusts, is undoubtedly that of the host, it is perhaps to be expected that a genus of hosts which includes an estimated number of 600 species, many of which show great variation, should harbor a large number of species of closely related parasites. The genus *Vernonia* occurs in both the Eastern and Western Hemispheres, over a wide range of latitude and under almost every conceivable condition of climate and range of elevation.

It is noticeable that the species of rusts under discussion are more numerous in the subtropical than in the temperate regions. For example, while but one species of *Puccinia* occurring on 9 species of *Vernonia* is known in the United States, 10 species occurring on 8 hosts are known from Guatemala and Costa Rica. Three host species, *V. patens*, *V. leiocarpha*, and *V. triflosculosa*, harbor two species each in the latter region. There are 17 different species recognized from North America, of which 4 have been collected in Mexico, 5 in the West Indies, and 10 in Guatemala and Costa Rica; 8 are known from South America and 3 from the Eastern Hemisphere; 2 species only are indigenous to both North and South America.

All of the material in the Arthur herbarium at the Purdue University Agricultural Experiment Station and in the herbarium of the New York Botanical Garden has been available in making this study. In addition, a very remarkable collection of unidentified specimens made by Professor E. W. D. HOLWAY in Guatemala

and Costa Rica was loaned to the writer for study by Dr. J. C. ARTHUR, to whom the material was sent. Professor HOLWAY has also kindly furnished other material from his very extensive herbarium. A number of collections made by the late W. A. KELLERMAN in Guatemala have also been included in this study. Most of the type collections of previously described species have been examined. A few from South America and Africa have not been seen, as the original specimens are in European herbaria and on account of the present unsettled conditions are not available.

The writer is under great obligations to Dr. J. C. ARTHUR and to Professor E. W. D. HOLWAY for the loan of material at their disposal and for reading the manuscript of this paper. Acknowledgment is also gratefully made to the members of the staff of the botanical department of the Purdue University Experiment Station for assistance in the details of the work. The species described as new from Guatemala and Costa Rica are published jointly under the authorship of Professor HOLWAY and the writer. The descriptions and notes, however, were prepared entirely by the writer, and he assumes all responsibility for any errors which future investigations may bring to light.

KEY TO SPECIES

- Teliospores smooth or appearing so, often obscurely rugose
 Teliospores colorless or light cinnamon brown, smooth
 Teliospores uniformly thick, rarely slightly thickened above
 Teliospores averaging more than 60μ in length
 Aecia present in life history
 Peridium present
 Teliospores $12-18\mu$ in width; urediniospores $19-22$ by $23-34\mu$
 1. *P. Becki*
 Teliospores $18-20\mu$ in width; urediniospores unknown.....
 2. *P. membranacea*
 Peridium wanting; urediniospores $23-28$ by $29-34\mu$. 3. *P. erratica*
 Aecia lacking in life history or unknown
 O, II, III present; teliospores $16-24$ by $56-80\mu$. . 4. *P. Arthuriana*
 III only described; spores $20-27$ by $45-70\mu$ 5. *P. vernoniicola*
 Teliospores averaging less than 60μ in length
 Teliospores less than 40μ long..... 6. *P. Vernoniae-mollis*
 Teliospores more than 40μ long
 Occurring on *Vernonia*

- O, II, III present in life cycle; urediniospore wall $1.5-2.5 \mu$ 7. *P. insulana*
- O, I, II, III present in life cycle; urediniospore wall $1-1.5 \mu$ 8. *P. fraterna*
- Occurring on *Piptocarpha*
- Teliospores $19-27$ by $35-58 \mu$ 28. *P. Piptocarphae*
- Teliospores $27-34$ by $45-60 \mu$ 29. *P. leptoderma*
- Teliospores appreciably thickened above
- Teliospores light brown; I and III known 9. *P. Le Testui*
- Teliospores colorless; II and III known 10. *P. hyalina*
- Teliospores dark cinnamon or chestnut brown, thickened at apex, frequently obscurely verrucose-rugose
- Uredinia unknown; teliospores chestnut brown, narrowed below
- Teliospores $20-25$ by $45-50 \mu$ 11. *P. vernoniphila*
- Teliospores $15-17$ by $40-50 \mu$ (micro-form) 26. *P. paupercula*
- Uredinia present; teliospores dark cinnamon or chestnut brown, rounded below
- Urediniospore wall cinnamon brown
- Urediniospore pores 4-6, scattered 12. *P. fuscella*
- Urediniospore pores 2-3, approximately equatorial
- Teliospores $20-28$ by $30-45 \mu$ 13. *P. Vernoniae*
- Teliospores $21-30$ by $40-60 \mu$ 14. *P. Lorentzii*
- Urediniospore wall colorless to faint golden brown 15. *P. semiinsculpta*
- Teliospore wall prominently roughened
- Uredinia with encircling paraphyses; teliospore markings tuberculate 16. *P. rata*
- Uredinia without paraphyses
- Teliospore markings verrucose or echinulate-verrucose
- Uredinia or urediniospores present in life cycle
- Markings of teliospore prominent and closely placed
- Urediniospores ellipsoid to obovoid, $18-21$ by $23-28 \mu$ 17. *P. idonea*
- Urediniospores globoid to obovoid, $22-26$ by $26-32 \mu$ 18. *P. notha*
- Markings prominent, sparsely distributed
- Urediniospore wall golden brown, thick; sori subepidermal 19. *P. egregia*
- Urediniospore wall colorless, thin; sori deep seated 20. *P. praealta*
- Uredinia and urediniospores unknown (micro-form) 27. *P. elephantopodis*
- Teliospore markings rugose or verrucose-rugose
- Telia gregarious or confluent (micro- or lepto-forms)
- Teliospores not or slightly constricted 21. *P. rotundata*
- Teliospores strongly constricted 22. *P. discreta*
- Telia scattered; urediniospores present (hemi- or brachy-forms)
- Teliospores averaging under 40μ in length 23. *P. inaequata*

Teliospores averaging over $40\ \mu$ in length

Spores with abrupt semihyaline umbo at apex..... 24. *P. pinguis*

Spores rounded at apex

Urediniospores sparsely echinulate, $18-26$ by $22-30\ \mu$, wall $1.5-3\ \mu$ thick..... 15. *P. semiinsculpta*

Urediniospores closely echinulate, $26-29$ by $29-34\ \mu$, wall $3-3.5\ \mu$ thick..... 25. *P. Kuntzii*

1. PUCCINIA BECKI Mayor, Mem. Soc. Neuch. 5:509. 1913.

O. Pycnia epiphyllous, few, gregarious on yellowish somewhat hypertrophied spots, $0.5-1$ mm. across, frequently extending along veins, conspicuous, subepidermal, orange yellow, fading to blackish, globoid or flask-shaped, $112-120$ by $125-130\ \mu$, ostiolar filaments $50\ \mu$ long.

I. Aecia hypophyllous, few or solitary, in groups opposite the pycnia, cylindrical; peridium white, membranous, lacerate; peridial cells seen only in face view, irregularly polyhedral, $16-23$ by $26-32\ \mu$, wall colorless, thin, $1.5-2\ \mu$, prominently verrucose-rugose; aeciospores globoid to ellipsoid, somewhat irregular, $16-22$ by $23-34\ \mu$, wall colorless, $2\ \mu$ thick, closely and prominently verrucose, with low warts often arranged in longitudinal lines, especially near either end, pores obscure.

II. Uredinia amphigenous, chiefly hypophyllous, scattered, small, $0.2-0.5$ mm. across, round, early naked, somewhat pulverulent, cinnamon brown, ruptured epidermis not conspicuous; urediniospores globoid or broadly ellipsoid, $18-22$ by $22-24\ \mu$, wall pale cinnamon brown, about $2\ \mu$ thick, moderately echinulate, pores obscure.

III. Telia chiefly hypophyllous, scattered, small, $0.2-0.5$ mm. across, round, early naked, compact, pulvinate, germinating at maturity, chestnut brown, ruptured epidermis not conspicuous; teliospores cylindrical or fusiform, $13-19$ by $58-90\ \mu$, wall cinnamon brown, $1-1.5\ \mu$ thick, smooth; pedicel colorless, fragile, short, up to $40\ \mu$ long.

On *Vernonia divaricata* Sw., I, II, III, Mandeville, Jamaica, February 23, 1915, Holway.

The collection from Jamaica already cited agrees in all essential features with the type of *P. Becki* in the uredinial and telial characters, and is assigned to that species with considerable confidence. In addition to the uredinia and

telia, the specimen bears mature aecia which without doubt belong in the life cycle, making it possible to complete the description. In the Arthurian classification this species would be assigned to the genus *Eriosporangium*. This species is known otherwise only from the type collection made by Mayor near Bogota, Department of Cundinamarca, Colombia, on *V. crotonaster*.

2. **PUCCINIA MEMBRANACEA** Diet., *Hedwigia* 38:251. 1899.

On *Vernonia cauloni* Sch., Tijuca, Rio de Janeiro, Brazil, May 1896, E. Ule 2337.

So far as can be determined from the literature, this species is known only from the type collection listed, which the writer has not seen. Only aecia and telia are described. It is evident from the description that it is closely related to the preceding species, although differing in the size of the aeciospores (25-30 by 30-35 μ) and in the width of the teliospores (18-20 by 60-90 μ), as well as in the absence of uredinia. The latter, however, in related rusts are often inconspicuous and sparingly developed and might easily be overlooked.

3. **Puccinia erratica** Jackson and Holway, nom. nov.—*Dietelia Vernoniae* Arth. BOT. GAZ. 40:198. 1905; *Endophyllum Vernoniae* Arth. N. Am. Flora 7:126. 1907.

O. Pycnia epiphyllous, numerous, in crowded groups, 1.0 mm. across, in the center of yellowish spots 0.5-1.0 cm. in diameter, conspicuous, subepidermal, orange becoming black, globose or flask-shaped, 120-145 by 145-160 μ , ostiolar filaments not extruded.

I. Aecia hypophyllous, few or solitary, crowded on the under side of yellowish spots opposite the pycnia or occasionally more or less scattered, bullate, 0.2-0.5 mm. across; peridium wanting; aeciospores somewhat irregularly ellipsoid, oblong or pyriform, 23-28 by 32-38 μ , somewhat flattened, wall colorless, 2-3 μ thick, prominently and closely verrucose-rugose, with a tendency to an arrangement in lines and uniting to form ridges at one end of the spore, tubercles often deciduous.

II. Uredinia hypophyllous, few, scattered, roundish, small, 0.1-0.3 mm. across, rather tardily naked, pulverulent, cinnamon brown, ruptured epidermis conspicuous; urediniospores globoid or broadly obovate, 23-28 by 29-34 μ , wall cinnamon brown, 1-1.5 μ , moderately echinulate, pores 3, approximately equatorial.

III. Telia hypophyllous, numerous, scattered or gregarious, round, small, 0.2-0.5 mm. across, early naked, pulvinate, chestnut brown, ruptured epidermis noticeable; teliospores cylindrical terete

or fusiform, 16–22 by 56–80 μ , narrowed at both ends, apex obtuse, not thickened, slightly constricted, wall cinnamon brown, thin, 1–1.5 μ , smooth, pedicel colorless, fragile, equaling the spore in length or usually shorter.

On *Vernonia Schiedeana* Less., Guatemala City, Guatemala, February 8, 1917, *Holway* 841, February 15, 1916, O, I, II, III, *Holway* 494; Chinautla, Guatemala, February 12, 1916, O, I, II, III, *Holway* 480; Moran, Dept. Amititlan, Guatemala, December 22, 1916, I, II, III, *Holway* 621; Cordoba, Vera Cruz, Mexico, January 27, 1895, O, I, II, III, *Pringle* 6080, from specimen in the phanerogamic herbarium of the New York Botanical Garden; Jalapa, Vera Cruz, Mexico, October 2, 1898, I, II, III, *Holway* 3111 (type of *Dietelia Vernoniae* Arth.).

In the course of the study of these collections it was at first thought that some of the specimens represented a mixture of *Endophyllum Vernoniae* and *Argomyces Vernoniae* (cf. 7), the aecia agreeing in morphology with the former and the uredinia and telia closely resembling the latter. A most careful examination, however, failed to reveal the presence of pycnia associated with the uredinia in any of the collections, and a re-examination of the type of *Endophyllum Vernoniae* showed a few telial sori and a few urediniospores which agree with those of the other collections. All of the collections cited show all spore stages of the rust and the association cannot be interpreted as accidental. The rust, according to this interpretation, is of the *Eriosporangium* type, possibly a correlated form with *Argomyces Vernoniae*. It is evidently closely related to the two preceding, differing, however, in the absence of a typical peridium in the aecia.

The Cordoba collection differs from the Guatemalan material in the somewhat broader teliospores, a greater proportion of which are shorter than the maximum measurements given. The aecia are usually solitary and occur on noticeably thickened areas rather than on yellowish spots as in most of the Guatemalan collections. The material is scanty, however, and the leaves are evidently from a more mature, less vigorously growing specimen of the host than the other collections.

4. **Puccinia Arthuriana**, nom. nov.—*Argomyces Vernoniae* Arth. N. Am. Flora 7:218. 1912, not *P. Vernoniae* Schw. 1832.

On *Vernonia arbuscula* Less., II, Pineland, Long Bay Cays Section, Andros, Bahamas, January 20–22, 1910, *J. K. Small* and *J. J. Carter* 8613; *Vernonia bahamensis* Griseb., II, III, North Caicos, Bellemont and vicinity, Bahamas, March 2, 1911, *C. F.* and *C. M. Millspaugh* 9175; II, Whiteland, Tenados, Inagua, Bahamas, October 28, 1904, *G. V. Nash* and *N. Taylor* 1344; II, Hanna Hill, Long Cay, Bahamas, December 7–17, 1905, *L. C. K. Brace* 4020; *Vernonia canescens* H.B.K., II, III, Volcan de Irazu, Cartago, Costa Rica,

December 24, 1915, *Holway* 281; San José, Costa Rica, January 3, 1916, O, II, III, *Holway* 360.

This species has previously been recorded only from Porto Rico,² on *V. albicaulis*, *V. borinquensis*, and *V. sericea* (*V. phyllostachya*). The specimen from St. Croix, listed with the original description, has since been referred to *Puccinia* (*Argomyces*) *insulana* (cf. 7). All but the last mentioned collections are from phanerogamic specimens in the herbarium of the New York Botanical Garden, obtained by the writer in January 1917. All are previously unrecorded hosts.

5. *PUCCINIA VERNONIICOLA* P. Henn. in Engler, Pfl. Ost.-Afr. c:50. 1895.

On *Vernonia* sp., Marangu, Africa, *Volk* 2257.

This species has not been seen by the writer and apparently has been recorded only from the type locality noted. Only telia and teliospores are described. SYDOW³ has evidently redescribed this from authentic material and his description of the sori (sparsis, rotundatis, 2-2.5 mm. diam., pulvinatis) would suggest that it is a lepto-*Puccinia* and not to be confused with any form yet recorded from North America.

6. *PUCCINIA VERNONIAE-MOLLIS* Mayor, Mem. Soc. Neuch. 5:510. 1913.—*Aecidium Vernoniae-mollis* Mayor, Mem. Soc. Neuch. 5:570. 1913.

This species was described from material collected by MAYOR in the central Andes, Dept. Antioquia, Colombia, on *Vernonia mollis* (?). Four collections of uredinia and telia were made, two of which correspond in data of place and date with collections of aecia on the same host described separately. Judging from the description of the aecia (only uredinia and telia having been seen by the writer), it would seem probable that the aecia belong in the life history as they appear to be of a type common in this group of rusts. If this surmise is correct, this species is of the *Eriosporangium* type. The matter is complicated by the fact that MAYOR made two collections of another uredo (*U. Vernoniae* Mayor) on the same host, one of which corresponds in data with one of the aecial collections. As pointed out by MAYOR, the final disposition of the various forms can be made only on more extended field observations or cultures. This species differs from all other related rusts on *Vernonia* in the small size of the teliospores (14-21 by 30-38 μ).

7. *Puccinia insulana* (Arth.), comb. nov.—*Argomyces insulanus* Arth. Mycologia 7:179. 1915.

² ARTHUR, J. C., Mycologia 7:180. 1915; 8:24. 1916; 9:67. 1917.

³ Monographia Uredinearum 1:177. 1902.

On *Vernonia divaricata* Sw., Oxford, Jamaica, September 13-18, 1906, *N. L. Britton* 431; Hillside, Blue Fields Mountain, Jamaica, March 6-7, 1908, *N. L. Britton* and *A. Hollick* 1996; *Vernonia longifolia* Pers., Antigua, West Indies, February 6, 1913, *J. N. Rose et al.* 3291; *Vernonia* sp., Retalhuleu, Guatemala, February 26, 1916, *Holway* 537.

This very distinct brachy-form was originally described from Porto Rico and St. Croix on *V. albicaulis* (*l.c.*) and on *V. longifolia* from Porto Rico. The above collections, excepting the last, were obtained from an examination of phanerogamic specimens in the herbarium of the New York Botanical Garden and, besides adding a new host for the species, extends the range to include Jamaica, Antigua, and Guatemala.

8. *Puccinia fraterna*, sp. nov.

O. Pycnia epiphyllous, few, gregarious, noticeable, subepidermal, blackish, globose, 110-120 μ in diameter, ostiolar filaments not protruding.

I. Aecia hypophyllous, few, crowded in small groups, opposite the pycnia, bullate, 0.2-0.5 mm. across; peridium short cylindrical, white, lacerate; peridial cells rectangular, abutted or slightly overlapping, 10-12 by 26-35 μ , wall colorless, outer wall smooth, 1.5 μ thick, inner very closely verrucose, 4 μ thick; aeciospores globoid or broadly ellipsoid, 18-23 by 23-32 μ ; wall colorless, 1-1.5 μ thick, closely and finely verrucose.

II. Uredinia hypophyllous, few, scattered, small, 0.2-0.5 mm. across, pulverulent, cinnamon brown, ruptured epidermis not conspicuous; urediniospores broadly ellipsoid or obovate, 23-26 by 26-32 μ ; wall pale cinnamon brown, 1-1.5 μ thick, moderately echinulate, pores 2 or 3, equatorial.

III. Telia hypophyllous, few, scattered, small, 0.2-0.5 mm. across, early naked, chestnut brown, ruptured epidermis not conspicuous; teliospores fusiform or oblong fusiform, 19-26 by 44-60 μ , narrowed above and below, somewhat constricted, wall cinnamon brown, uniformly 1 μ thick, smooth; pedicel colorless, fragile, about half the length of the spore.

On *Vernonia pluvialis* Gleason, Summit Blue Mt. Peak, Jamaica, July 24, 1903, O, I, II, III, *G. E. Nichols* 120 (type); May 14, 1906, O, I, *Forrest Shreve*.

The specimens on which this species is based were obtained from phanerogamic specimens in the herbarium of the New York Botanical Garden. The first collection mentioned bears all stages of the rust; the other, found on the type specimen of the host species, bears pycnia and aecia only. The material

is fragmentary and admitting of rather incomplete description of some stages. The species, however, is clearly distinct from any form previously described, having medium sized teliospores and possessing aecia with peridia. It is apparently most closely related to *P. insulana*, and difficult to separate from it in the uredinial and telial characters. The urediniospores, however, have thinner walls and the teliospores are somewhat narrower. The presence of aecia, however, clearly distinguishes it from that species. It should doubtless be considered a correlated form.

9. **PUCCINIA LE TESTUI** Maubl. Bull. Soc. Myc. Fr. 22:71. 1906.

This species is known only from Marromen, East Africa, on *Vernonia* sp. No material has been available for study. Aecia and telia only are known, the latter described as oblong to ellipsoid-oblong, apex rounded, base narrowed, constricted at the septum, wall thick, apex thickened to 8μ , papillate, smooth, "flavo-brunneis," 18-25 by $36-50\mu$, pedicel subhyaline, persistent, to 50μ long. From this it would appear to be different from any other described species, although possibly close to *P. fuscella*.

10. **Puccinia hyalina**, sp. nov.

O and I. Pycnia and aecia unknown.

II. Uredinia amphigenous, scattered, occasionally gregarious, roundish, 0.2-0.4 mm. across, tardily naked, pulverulent, cinnamon brown, ruptured epidermis conspicuous; urediniospores broadly ellipsoid or obovoid, 22-26 by $29-34\mu$, wall dark cinnamon brown, $1.5-2.5\mu$ thick, strongly and sparsely echinulate; pore one, basal, near the hilum.

III. Telia hypophyllous, scattered or gregarious, round, small, 0.2-0.4 mm. across, early naked, pulvinate, whitish or cinereous, ruptured epidermis not conspicuous; teliospores ellipsoid or obovoid, 18-22 by $36-46\mu$, rounded at apex and base or narrowed below, slightly constricted, germinating at maturity; wall colorless, thin, 1μ , thickened at apex to $6-8\mu$, smooth; pedicel colorless, equaling the spore.

On *Vernonia scariosa* Arn., Ceylon, April 23, 1915, T. Petch.

A very distinct species, easily separated from all other rusts on *Vernonia* by the single basal pore of the urediniospore and the colorless teliospores appreciably thickened at the apex.

11. **PUCCINIA VERNONIPHILA** Speg. Ann. Mus. Buenos Aires 19:306. 1909.

Only one collection of this species has been recorded, on *V. flexuosa* from Buenos Aires, November 1907. No material has been available for study, and its relation to the other species cannot be stated with any degree of accuracy. Telia only are described, the spores being "obscure fusco-ferrugineae superne obtusae inferne subcuneatae (20-25 by 45-50 μ) . . . non v. leniter constrictae, episporio ad vesticem sat incrassato." The description of the sori would not suggest a micro- or lepto-form, and it is probable that other stages exist.

12. PUCCINIA FUSCELLA Arthur and Johnston, Mem. Torr. Bot. Club 157. 1918.

On *Vernonia menthaefolia* Less., El Yunque Baracoa, Cuba, March 10, 1903, *E. W. D. Holway*; Baracoa, April 14, 1916, *J. R. Johnston* 584 (type).

This species has formerly been confused with *P. Vernoniae* Schw. (cf. 13). It differs, however, in well marked characters, especially in the distribution of the pores in the urediniospores, which are 4-6 and scattered, while in *P. Vernoniae* they are 3 and equatorial. The species is known only from Cuba. The first mentioned specimen was issued as no. 772 in Barth. N. A. Ured. as on *V. longifolia*.

13. PUCCINIA VERNONIAE Schw. Proc. Am. Phil. Soc. II. 4:296. 1832.—*P. bullata* Schw. Schrift. Nat. Gesell. Leipzig 1:74. 1822; not *P. bullata* Lk. 1815 or Schroet. 1879; *P. tanaceti Vernoniae* Burr. Ill. Lab. Nat. Hist. 2:186. 1885; *P. Vernoniae longipes* Diet. Jour. Mycol. 7:43. 1891; *P. Vernoniae brevipes* Diet. Mycol. 7:43. 1891; *P. longipes* Lagerh. Tromsö Mus. Aarsh. 17:64. 1895; *Dicaeoma longipes* Kuntze, Rev. Gen. 3:469. 1898; *Bullaria Vernoniae* Arth. Mycol. 2:302. 1917.

O. Pycnia epiphyllous, few, scattered among the uredinia, small, punctiform, subepidermal, honey yellow, becoming brown, globose, 112 μ in diameter by 120-130 μ in height; ostiolar filaments free.

II. Primary uredinia chiefly epiphyllous, rather numerous, crowded in groups up to 4 mm. in length, often confluent, small, round, 0.3-0.5 mm. across, rather early naked, pulverulent, cinnamon brown, ruptured epidermis inconspicuous; secondary uredinia amphigenous, often gregarious like the primary on yellow spots, or more often scattered, small, 0.2-0.5 mm. across, ruptured epidermis often conspicuous; urediniospores obovoid or broadly ellipsoid, 20-26 by 22-30 μ ; wall cinnamon brown, 1.5-3 μ thick, moderately to sparsely and prominently echinulate; pores 3, approximately equatorial.

III. Telia amphigenous and caulicolous, on the leaf blades often gregarious or confluent, in groups of 0.5–1.5 mm., more often scattered, round, 0.2–0.5 mm. across, on the stems fusiform, 10–30 mm. long; early naked, becoming somewhat pulverulent, dark chocolate brown, ruptured epidermis noticeable when epiphyllous, inconspicuous when hypophyllous; teliospores oblong or ellipsoid, often irregular, 20–28 by 30–45 μ , somewhat longer and narrower in caulicolous sori, 19–26 by 40–58 μ , obtuse or rounded above, rounded or narrowed below, slightly or not constricted at septum (more frequently so in caulicolous form); wall light chestnut brown, minutely verrucose, often appearing smooth, medium thick, 1.5–3 μ , thicker at apex, 5–10 μ , concolorous or often slightly lighter above; pedicel colorless, slender, once to twice the length of the spore, in the caulicolous form usually much longer.

On *Vernonia altissima* Nutt. (*V. maxima* Small), Indiana, Michigan; *V. Baldwinii* Torr. (*V. interior* Small), Illinois, Kansas, Michigan, Nebraska, Oklahoma; *V. crinita* Raf., Arkansas, Michigan; *V. Ervendbergii* Gray, San Luis Potosi; *V. fasciculata* Michx., Illinois, Iowa, Michigan, Nebraska, North Dakota, Oklahoma, South Dakota; *V. gigantea* (Walt.) Britt., Texas; *V. guadalupensis* Heller, Texas; *V. missourica* Raf. (*V. Drummondii* Shuttlw.), Missouri; *V. noveboracensis* (L.) Willd., Delaware, Illinois, Iowa, North Carolina; *V. pulchella* Small, Georgia; *V. sp.*, Virginia.

Type locality: Salem, North Carolina, on *Vernonia noveboracensis*.

Exsiccati: Sydow Ured. 273, 1015; Ellis and Ev. N. A. Fungi 1847, 2988, 3050; Ellis and Ev. Fungi Columb. 263, 353, 1670, 1774; Barth. Fungi Columb. 2573, 2970, 3271, 3674, 4276; Barth. N. A. Ured. 69, 70, 578, 873, 874, 973; Brenckle, Fungi Dakot. 369; Seym. and Earle, Econ. Fungi Suppl. B 20.

This very common species is apparently confined to the United States, and the only one so far recorded north of Mexico. The name first proposed by SCHWEINITZ was based on collections made at Salem, North Carolina, occurring "erumpent from the dried stems of various plants, e.g. *Ambrosia*, *Chenopodium*." In his later publication he cites it as occurring in Pennsylvania on *V. noveboracensis*. An examination of the material in the Schweinitz collection at the Philadelphia Academy of Science made by ARTHUR, shows that there are three packets, containing in the aggregate 9 pieces, of similar stems bearing large sori up to 3 cm. long. The original packet reads "*P. bullata* LvS. Salem and Beth. in caulibus varies." The stems all appear to be of *Vernonia*, and the rust when examined microscopically does not differ from similar material on *Vernonia* stems (now interpreted as *V. altissima*) collected by UNDERWOOD at Fern, Putnam County, Indiana, and distributed in Ellis and Ev. N. A. Fungi (2988) and other exsiccati under the name *P. Vernoniae*

Schw. No other rust with which this could possibly be confused is known to occur on the stems of *Ambrosia* or *Chenopodium*, or on any other host within the range of this species.

LAGERHEIM based his *P. longipes* on material of *P. bullata* Schw. in the E. Fries herbarium, communicated by SCHWEINITZ, said to be on culms or petioles of *Ambrosia* sp.

DIETEL (*l.c.*) based his varieties on supposed differences in the length of the pedicel in this rust on different hosts, a difference which is not borne out by an examination of the large series of specimens in the Arthur herbarium.

That the rust on the stems is the same as the more common, or at least more frequently collected, form on the leaves has been shown by ARTHUR, who, in 1916 (*Mycol.* 9:302, 1917), using telial material from the stems of *Vernonia* sp. collected by C. H. CRABILL at Cliffview, Va., and communicated by F. D. FROMME, succeeded in obtaining the development of pycnia and uredinia on the leaves of *Vernonia* sp. This culture also demonstrates that this rust, whose life history has long been in doubt, is a brachy-form referable to the genus *Bullaria*. Pycnia have not been observed in any field collections thus far studied.

14. PUCCINIA LORENTZII P. Henn. *Hedwigia* 35:239. 1896.

The type of this species was collected by LORENTZ in Argentina, February 1878, on *Vernonia Lorentzii* Hieron. It is also recorded from the same region on *V. mollissima* and from Brazil on *V. scorpioides*. The only specimen recorded by HENNINGS, which has been seen by the writer, is presumably the collection which he records as on *Vernonia* sp. made by E. Ule (1414) in Sta. Cathrina pr. Tubarao, Brazil. The specimen examined is from the herbarium of E. W. D. HOLWAY and agrees with the data given by HENNINGS, except that the host is *V. scorpioides* and the number 1441. This specimen bears uredinia only, and the spores, as stated by HENNINGS, differ slightly from those of the other collections. The spores are ellipsoid to obovoid, 23-24 by 26-32 μ , wall cinnamon brown, 1.5-2 μ thick, minutely and moderately echinulate, the pores 3, equatorial. Another specimen distributed by VESTER-GREN (*Micromycetes rariores selecti* 1289), collected by Rob. E. Fries in Prov. Jujuy, Argentina, on *V. scorpioides*, has been examined and found to bear uredinia only, the spores being similar to the Ule collection. In the absence of other material for examination it is possible that the assignment in the preceding key is incorrect.

15. PUCCINIA SEMIINSCULPTA Arth. *BOT. GAZ.* 40:204. 1905.

O. Spermogonia epiphyllous, few in small groups, punctiform, honey yellow becoming brown, immersed, subepidermal, globose, 150-180 μ across.

II. Primary uredinia epiphyllous, surrounding the pycnia on yellowish hypertrophied spots with purple border, secondary scattered, round, small, 0.2–0.3 mm. across, soon naked, pale cinnamon brown, pulverulent, ruptured epidermis noticeable; urediniospores broadly ellipsoid, obovoid, or globoid, 18–26 by 22–30 μ ; wall golden yellow fading to nearly colorless, medium thick, 1.5–3 μ , sparsely and evenly echinulate, pores indistinct, 2–3 and equatorial.

III. Telia amphigenous, or often only epiphyllous, scattered, round, small, 0.2–0.5 mm. across, often confluent, soon naked, chocolate brown, compact and cinereous from germination or pulverulent, ruptured epidermis inconspicuous; teliospores elliptical or elliptical-obovate, 22–38 by 38–50 μ , rounded above, rounded or somewhat narrowed below, slightly or not constricted at septum; wall finely to coarsely reticulate-verrucose with irregular, crowded sculpturing, golden brown in the germinating form to chocolate brown in the pulverulent form, 3–6 μ thick, slightly or not thicker at apex, 4–10 μ , much thinner at base in the germinating form; pedicel colorless, rather slender, 5–9 μ thick, once to twice length of spore, minutely rugose, or nearly smooth.

On *Vernonia Alamani* DC., Amecameca, Mexico (state), October 31, 1899, *Holway* 3754 (type), distributed in Barth. Fungi Columb. 4573; October 30, 1903, *Holway* 5190, distributed in Barth. N. A. Ured. 168; Oaxaca, November 11, 1903, *Holway* 5379; Patzcuaro, Michoacan, October 13, 1899, *Holway* 3631; October 10, 1899, *Holway* 3602; October 17, 1898, *Holway* 3105; *V. Karwinskiana* DC., Las Sedos, Oaxaca, Mexico, October 30, 1894, *C. G. Pringle* 6019; *V. umbellifera* Gleason, Guadalajara, Jalisco, Mexico, October 16, 1889, *C. G. Pringle* 2316; *Vernonia* sp., Oaxaca, Mexico, October 18, 1899, *Holway* 3668, distributed in Barth. N. A. Ured. 1570; Chapala, Mexico, September 19, 1899, *Holway* 5459; Cuernavaca, Mexico, September 30, 1899, *Holway* 3540; Morelos, Mexico, September 8, *Arsène* (Field Museum, sheet 386949).

This remarkable species presents some puzzling features. The teliospores, as stated in the description, are of two forms, quite different in general characters. The thin-walled, lighter colored spores are often found in a germinating condition. The thick-walled, darker spores show no evidence of germination. All gradations between the extremes of the two forms may be found in the same collection and even in the same sorus. It is possible that this species should be regarded as indicating a transitional relation between the *Argomyces* type and the usual form.

The species as here considered follows closely the original interpretation of ARTHUR. It should be noted that certain collections (*Holway* 3459, 3668) show only the thick-walled form, and the sori are chiefly epiphyllous, while in the typical form the sori are chiefly hypophyllous. The two *Pringle* collections add new hosts for the species. The first mentioned was obtained through the courtesy of HOLWAY, the other from a phanerogamic specimen in the herbaria of the New York Botanical Garden and of the Field Museum (sheets 104882, 262977).

16. ***Puccinia rata*** Jackson and Holway, sp. nov.

O and I. Pycnia and aecia unknown.

II. Uredinia amphigenous, chiefly hypophyllous, scattered, round, standing out from surface of leaf, small, 0.2–0.4 mm. across, early naked, becoming pulverulent, cinnamon brown, epidermis not conspicuous; surrounded by abundant encircling paraphyses, standing well out from substratum, paraphyses incurved, clavate, 15–18 by 100–125 μ , wall colorless or very slightly tinted with brown, uniform, thin, 0.5–1 μ ; urediniospores globoid or broadly obovate, 24–29 by 26–32 μ ; wall dark cinnamon brown, 2.5–3.5 μ thick, rather closely echinulate; pores 4–5, scattered.

III. Telia hypophyllous, scattered or gregarious, round, small, 0.2–0.4 mm. across, early naked, becoming pulverulent, early formed sori surrounded by paraphyses like the uredinia, later formed sori without paraphyses; teliospores broadly ellipsoid, 26–30 by 32–42 μ , rounded at both ends, slightly or not constricted at septum; wall uniform, chestnut brown, 3.5–5 μ thick, thickened to 5–7 μ at apex and over pore of lower cell, which is usually placed half way from pedicel to septum, prominently and evenly tuberculate with closely set low tubercles, 1 μ in height, having polygonal bases; pedicel short, 5–10 μ , colorless, deciduous.

On *Vernonia leiocarpa* DC., Guatemala City, Guatemala, February 13, 1916, II, III, *Holway* 490 (type); February 15, 1916, II, III, *Holway* 495a; March 17, 1916, II, III, *Holway* 585; Mendez, Dept. Guatemala, February 13, 1917, *Holway* 860; Antigua, Dept. Sacatepequez, February 4, 1907, *Kellerman* 6300.

Known only from Guatemala, this very distinct species is easily separated from all others on *Vernonia*, studied by the writer, in the presence of abundant paraphyses with the uredinia and in the tuberculate markings of the teliospores. It is accompanied on some of the collections (*Holway* 495a, *Kellerman* 6300)

by another species, *P. notha* (18), from which it is, however, readily distinguished by well marked characters. In *P. notha* the uredinia are not accompanied by paraphyses and the spores are colorless. The teliospores, while similar to the present species in shape and size, have verrucose markings and long pedicels. In *P. rata* the sori are in general hypophyllous, while in *P. notha* they are characteristically epiphyllous on the specimens examined.

17. ***Puccinia idonea*** Jackson and Holway, sp. nov.

O and I. Pycnia and aecia unknown.

II. Uredinia amphigenous, scattered or somewhat crowded and frequently confluent along the midribs and larger veins, roundish or somewhat elongated, 0.3–0.6 mm. across, early naked, pulverulent, lemon yellow fading to white, ruptured epidermis conspicuous; urediniospores broadly ellipsoid or obovoid, 18–21 by 23–28 μ , wall colorless, thin, 1–1.5 μ , finely and moderately echinulate, the pores obscure but apparently equatorial.

III. Telia amphigenous, chiefly hypophyllous, scattered or somewhat crowded and frequently confluent along the midribs and larger veins, roundish or somewhat elongated 0.3–0.6 mm. across, early naked, pulvinate becoming pulverulent, blackish brown, ruptured epidermis conspicuous; teliospores broadly ellipsoid, 23–28 by 35–45 μ , rounded at both ends, not or scarcely constricted, wall chestnut brown, medium thick 3–4 μ , slightly thickened at apex and over pore of lower cell to 7 μ , prominently and evenly verrucose with broad low projections rather closely set, sometimes arranged in lines; pedicel colorless, flexuous, twice the length of the spore, 3–5 μ thick, transversely rugose at base and swelling slightly.

On *Vernonia triflosculosa* H.B.K., San Jose, Costa Rica, January 8, 1916, *Holway* 398; January 18, 1916, *Holway* 445; Chinaulta, Dept. Guatemala, February 12, 1916, II, III, *Holway* 481; Esquintla, Guatemala, February 17, 1916, II, III, *Holway* 498, 499, type; Panajachel, Dept. Solola, Guatemala, January 3, 1917, II, III, *Holway* 670.

This species occurs on the same host and from the same region as *P. praealta* (cf. 20), but differs in the character of the sori as well as in microscopic characters. It is perhaps most closely related to the next described species. The urediniospores, however, are narrower and shorter, with little or no tendency to be globoid. The teliospores in this species, while similar in size and shape, have markings which are less pointed and hence nearly hemispherical and somewhat more closely placed. The pedicel has a tendency to swell slightly

at the base, while in the latter it is attenuated. The uredinia in gross appearance resemble those of *Coleosporium*. The spores, however, are echinulate and borne on pedicels, and sections show urediniospores and teliospores in the same sorus.

18. ***Puccinia notha*** Jackson and Holway, sp. nov.

O. Pycnia epiphyllous, few, gregarious, inconspicuous, sub-epidermal, depressed globoid or conical, 60–90 by 50–90 μ , ostiolar filaments short.

I. Aecia hypophyllous, few, gregarious on somewhat thickened spots, peridium cylindrical, whitish, membranous, rupturing irregularly, peridial cells seen only in face view, irregularly polyhedral or rectangular, 18–26 by 35–48 μ , wall colorless, thin, 1–2 μ , closely verrucose-rugose; aeciospores somewhat irregularly ellipsoid or globoid, 20–26 by 26–35 μ , wall thin 1–1.5 μ , closely verrucose, markings somewhat deciduous, pores not evident.

II. Uredinia amphigenous, few, scattered, round, very small, 0.1–0.2 mm. across, early naked, pulverulent, whitish, ruptured epidermis not conspicuous; urediniospores globoid or obovoid, 22–26 by 26–32 μ ; wall colorless, 1.5–3 μ thick, moderately echinulate; pores obscure.

III. Telia amphigenous, chiefly epiphyllous, scattered or gregarious, small, 0.2–0.8 mm. across, early naked, becoming pulverulent, blackish brown, ruptured epidermis not conspicuous; teliospores broadly ellipsoid, 26–34 by 35–48 μ , rounded at both ends, slightly or not constricted, wall chestnut brown, 3.5–5 μ thick, slightly thickened by a subhyaline umbo to 7 μ at apex and over pore of lower cell which is usually placed near pedicel or half way between pedicel and septum, prominently, evenly and moderately verrucose, with acute points about 3–4 μ apart; pedicel colorless, persistent, firm, once to two and a half times the length of the spore, 5–7 μ thick, tapering and minutely verrucose at the lower end, often attached laterally.

On *Vernonia leiocarpa* DC., San Rafael, Guatemala, January 7, 1915, Holway 21; Solola, 7000 ft., January 28, 1915, I, II, III, Holway 148 (type); Antigua, February 4, 1907, Kellerman 6300a; Volcan de Agua, Antigua, March 4, 1916, II, III, Holway 550; Guatemala City, February 15, 1916, III, Holway 495; March 17, 1916, III, Holway 585a; Huehuetnango, January

21, 1917, I, II, III, *Holway* 759; Quezaltenango, January 16, 1917, I, II, III, *Holway* 732; *V. Shannoni* Coulter (?), Quezaltenango, January 31, 1917, *Holway* 814.

Known only from the above mentioned collections from Guatemala. As previously noted (cf. 16), this species is often accompanied on the same leaves with *P. rata*, from which it differs in well marked characters. It is closely related to *P. idonea* (cf. 17) and perhaps to *P. egregia* (cf. 19). In the Quezaltenango collection (732) the teliospores have much shorter pedicels than in the other collections, and the sori are equally abundant on both surfaces of the leaf, instead of being chiefly epiphyllous as in all the other collections examined.

19. *PUCCINIA EGREGIA* Arth. BOT. GAZ. 40:204. 1905.

II. Uredinia not seen; urediniospores from telial sori globoid or obovoid, 23–26 by 24–28 μ ; wall golden yellow, medium thick, 1.5–2.5 μ , moderately echinulate; pores obscure, apparently 3 equatorial.

III. Telia amphigenous, scattered, round, 0.2–0.5 mm. across, early naked, pulvinate, becoming somewhat pulverulent, chocolate brown, ruptured epidermis inconspicuous; teliospores broadly ellipsoid, 26–30 by 35–45 μ , rounded at both ends, not constricted at septum; wall chestnut brown, very thick, 4–6 μ , very slightly thickened at apex and over pore of lower cell, the latter placed near the pedicel, uniformly coarsely and prominently verrucose with conical and well separated papillae; pedicel slender, 4–6 μ thick, once to twice the length of the spore or occasionally longer, wall thin, smooth, colorless.

On *Vernonia uniflora* Schz. Bip.

Known only from a single collection, obtained from a phanerogamic specimen in the herbarium of the New York Botanical Garden, on *V. uniflora*, collected at Oaxaca, Mexico, December 29, 1895, by *Seler* (1739). The material is very meager and admits of but incomplete description. It is, perhaps, very closely related to *P. notha* (cf. 18), from which it differs in the somewhat more prominent, very sparsely distributed, rather more sharply pointed markings on the teliospore wall. The urediniospore wall is golden yellow instead of colorless, as in *P. notha*.

20. *Puccinia praealta* Jackson and Holway, sp. nov.

O and I. Pycnia and aecia unknown.

II. Uredinia epiphyllous, densely gregarious and often confluent on irregular spots, 0.5–2 mm. across, bullate, 0.2–0.4 mm. across, long covered by the overarching and conspicuous epidermis, deep

seated, arising from below the palisade layer, pulverulent, light yellow fading to whitish; urediniospores ellipsoid or obovoid, 18–20 by 24–28 μ , wall pale yellow or colorless, thin, 1–1.5 μ , finely and moderately echinulate, pores obscure, apparently 2 equatorial.

III. Telia epiphyllous, densely gregarious and often confluent on irregular spots, 0.5–1.5 mm. across, becoming scattered, bullate, 0.2–0.4 mm. across, long covered by the overarching and conspicuous epidermis, deep seated, arising from below the palisade layer, compact, chestnut brown; teliospores ellipsoid, 24–28 by 32–40 μ , rounded at both ends, slightly or not constricted at septum, wall light chestnut brown, 3–4 μ thick, slightly thickened over the pore of either cell, 4–5 μ , rather prominently and sparsely verrucose, with conical projections; pedicel colorless, once to twice length of spore.

On *Vernonia triflosculosa* H.B.K., Mazatenango, Guatemala, February 21, 1916, *Holway* 510 (type); San Jose, Costa Rica, II, III, January 10, 1916, *Holway* 407; San Ramon, Costa Rica, January 13, 1916, II, *Holway* 426; Heredia, Costa Rica, December 17, 1915, II, *Holway* 262.

A very distinct species, separable from all others on *Vernonia* by the very deep seated, strictly epiphyllous sori, arising from beneath the palisade layer of leaf tissue. The sori are aggregated in definite groups, presenting the appearance, on cursory examination, of a micro-form. It is quite different from *P. idonea* (cf. 17), which occurs on the same host from the same region.

21. PUCCINIA ROTUNDATA Diet. *Hedwigia* 36:32. 1897.—*P. rugosa* Speg. *Ann. Soc. Cient. Argent.* 17:92. 1884; not *P. rugosa* Billings 1871.

O. Pycnia amphigenous, among the telia, few, gregarious, noticeable, yellowish, subepidermal, globose or somewhat flask-shaped, 125–130 by 125–130 μ , ostiolar filaments not extruded.

III. Telia amphigenous or chiefly epiphyllous and caulicolous, numerous, crowded on yellowish spots in orbicular or somewhat irregular areas, 0.5–5 mm. across, roundish, 0.2–0.5 mm. across, tardily naked, becoming pulverulent, reddish brown, ruptured epidermis conspicuous; teliospores ellipsoid, 18–26 by 30–42 μ , rounded at both ends or occasionally tapering below, not or slightly constricted, cells easily separating; wall cinnamon brown, uniformly thick, 2.5–3 μ or occasionally thickened to 4–5 μ over pores, which are located about half way from apex to septum in the upper cell

and similarly placed between pedicel and septum in the lower cell; noticeably and evenly rugose; pedicel short, colorless, deciduous.

On *Vernonia patens* HBK., Orotina, Costa Rica, January 1, 1916, Holway 343; *Vernonia* sp., Colombia, Panama, September 1890, G. Lagerheim.

This species is based on specimens collected by E. Ule (1686) at Serra Geral, Brazil, February 1891, on an unknown composite. Later DIETEL (*Hedwigia* 38:251. 1899) refers a specimen to this species collected by Ule (2336) on *V. Tweediana*, at Gavea, Rio de Janeiro, Brazil, June 1897. The first specimen mentioned has not been examined by the writer, but a specimen on *V. Tweediana* from the herbarium of HOLWAY, collected by Ule at Jacarepagua, Rio de Janeiro, October 1897, bearing the same number (2336) as the Gavea specimen, has been studied. This material agrees with Sydow Ured. 1605 on the same host from Gavea, Brazil, collected by Höhnel, August 1899 and referred to *P. rugosa* Speg. A specimen in the herbarium of the New York Botanical Garden on *Vernonia* sp. from Campinas, Brazil, collected by F. Noack, May 1898, is the same. The specimen from Panama is in the herbarium of the New York Botanical Garden and is marked *P. panamensis* Lagerh. n. sp., which was apparently never described. MAYOR (*Mem. Soc. Neuch. Sci. Nat.* 5:511, 512. 1913) reports this species as *P. rugosa* Speg., on *V. patens* and *V. scabra*, from Colombia, having made several collections on the former host and one on the latter. None of MAYOR'S collections have been seen, but a specimen was obtained on *V. scabra* in the phanerogamic collection of the Field Museum (sheet 137666) made at Santa Marta, Colombia, December 1898-1901 by H. H. Smith (613). The type of *P. rugosa* has not been seen. The description and range indicate, however, that it is identical with *P. rotundata*, as has been previously assumed by SYDOW (*Monog. Ured.* 1:176. 1902). *P. rugosa* was described as occurring on an unknown composite, questionably *Verbesina*. Its exact status will remain somewhat in doubt until authentic material can be compared.

22. ***Puccinia discreta*** Jackson and Holway, sp. nov.

O. Pycnia epiphyllous, surrounded by the telia, few, gregarious, noticeable, subepidermal, golden brown fading to dark brown, globoid or depressed globoid, 90-100 by 100-130 μ ; ostiolar filaments short.

III. Telia chiefly epiphyllous, densely gregarious and confluent in groups 0.5-3 mm. across, on yellowish hypertrophied spots, often arranged in a concentric manner around the pycnia, roundish or somewhat irregular, 0.2-0.6 mm. across, early naked, at first punctiform, becoming pulverulent, dark cinnamon brown, ruptured epidermis conspicuous; teliospores ellipsoid, 18-22 by 32-42 μ ,

rounded at both ends, cells easily separating, strongly constricted at septum, wall dark cinnamon brown, uniform in thickness, $2.5-3.5 \mu$, minutely verrucose-rugose, often in lines extending in various directions; pore of apical cell placed about half way from apex to septum, similarly in lower cell; pedicel colorless, usually deciduous.

On *Vernonia Deppeana* Less., San Jose, Costa Rica, December 15, 1915, *Holway* 260 (type), January 3, 1916 (363), January 10, 1916 (406), December 27, 1915 (305); Sierra de las Minas, alt. 3500, El Rancho, Dept. Baja Verapaz, Guatemala, January 3, 1908, *W. A. Kellerman* 7026; San Felipe, Retalhuleu, Guatemala, January 14, 1917, O, III, *Holway* 721; Colomba, Dept. Quezaltenango, Guatemala, February 2, 1917, *Holway* (818).

A very distinct species, related to *P. rotundata* Diet., but easily separated by the strongly constricted teliospores and in the less conspicuous character of the markings of the teliospore wall.

23. ***Puccinia inaequata*** Jackson and Holway, sp. nov.

O. Pycnia epiphyllous, few, gregarious in the center of lighter colored spots, noticeable, subepidermal, depressed globoid, $100-120 \mu$ high by $100-175 \mu$ broad; ostiolar filaments short.

II. Primary uredinia chiefly epiphyllous, crowded and somewhat confluent in concentric groups, 2.2 mm. across, surrounding the pycnia, early naked, pulverulent, cinnamon brown, ruptured epidermis conspicuous; secondary uredinia amphigenous, numerous, scattered, roundish, small, 0.2-0.5 mm. across, early naked, pulverulent, cinnamon brown, ruptured epidermis noticeable; urediniospores obovoid or broadly ellipsoid, $18-23$ by $23-28 \mu$, pale cinnamon brown, $1.5-3 \mu$ thick, prominently and sparsely echinulate, pores 2 or 3, approximately equatorial.

III. Telia amphigenous, scattered, round, small, 0.2-0.5 mm. across, early naked, at first pulvinate becoming somewhat pulverulent, blackish brown, ruptured epidermis conspicuous; teliospores oblong or broadly ellipsoid, $22-26$ by $30-38 \mu$, rounded at both ends, not or scarcely constricted; wall dark cinnamon or chestnut brown, $2.5-3 \mu$, slightly thickened at apex, $4-5 \mu$; finely and evenly verrucose-rugose; pedicel colorless, short, usually deciduous, often laterally attached; pore of lower cell below the middle.

On *Vernonia patens* H.B.K., Esquintla, February 17, 1916, *Holway*, O, I, II, 502 (type); Mazatenango, February 22, 1916, II, *Holway* 513; Sanarate,

III, February 10, 1916, *Holway* II, III, 470; Retalhuleu, February 26, 1916, O, II, *Holway* 534; Salama, March 2, 1907, *Kellerman*; El Rancho, January 25, 1905, *Kellerman* 5337; Agua Caliente, February 10, 1917, II, III, *Holway* 851; Santa Rosa, February 1893, *Heyde* and *Lux*, from phanerogamic specimen 4524 *Plantae Guatemalensibus*, ed. by JOHN DONNELL SMITH, in the Columbia University collection.

This species is known only from the localities listed above in Guatemala. It is easily separated from all other species on *Vernonia*, having distinct rugose markings on the teliospore wall, and by the small spores thickened at the apex.

24. *Puccinia pinguis* Diet. *Hedwigia* 36:32. February 1897; not *P. pinguis* Diet. and Holw. July 1897.

Known only from the type collection on *Vernonia platensis*, Serra Geral, Brazil, February 1891, *E. Ule* 1692. A part of the type from the herbarium of HOLWAY has been examined, and it proves to be quite distinct. The teliospores are irregularly ellipsoid or oblong, 24-30 by 42-52 μ , slightly or not constricted, wall chestnut brown, 2.5-4 μ thick, apex usually abruptly thickened by a subhyaline papilla to 5-9 μ . Some spores show scarcely any thickening. The wall is obscurely and very minutely rugose. A few colorless urediniospores were observed in one mount. They are globose or broadly ellipsoid, 20-23 by 20-23 μ , wall 1-1.5 μ thick, very minutely and closely echinulate.

25. *Puccinia Kuntzii*, sp. nov.

O and I. Pycnia and aecia unknown.

II. Uredinia not seen; urediniospores intermingled with teliospores, somewhat irregularly globoid to ellipsoid, 26-29 by 29-34 μ ; wall golden brown, 3-3.5 μ thick, closely echinulate, pores obscure, probably scattered.

III. Telia hypophyllous, numerous, scattered, roundish, 0.2-0.5 mm. across, early naked, becoming pulverulent, blackish brown, ruptured epidermis not conspicuous; teliospores broadly ellipsoid or oblong, rounded at either end, occasionally somewhat narrowed below, not or slightly constricted, wall dark chestnut brown, 5.5-7.5 μ thick, apex slightly thickened 8-10 μ , prominently and closely verrucose-rugose, pore of lower cell situated midway between septum and pedicel; pedicel colorless, flexuous, one half to twice length of spore, often deciduous.

The specimen on which this species is based was obtained from a phanerogamic specimen in the herbarium of the New York Botanical Garden, labeled

Vernonia Kuntzii Hieron., Santa Cruz, Bolivia, May 1892, *Otto Kuntze*. It is perhaps related to *P. semiinsculpta*, from which it differs chiefly in the broader, more closely echinulate urediniospores.

26. PUCCINIA PAUPERCULA Arth. BOT. GAZ. 40:206. 1905.—
P. Elephantopodis-spicati Pat. Bull. Soc. Myc. Fr. 28:140. 1912.

This species, known only on *Elephantopus spicatus* Juss., was originally described from a collection made by *E. W. D. Holway* (3074) at Vera Cruz, Mexico, October 5, 1898. A second collection was made by *Holway* at San Jose, Costa Rica, January 3, 1916 (353). Collections have also been made by *Holway* at Mazatenango, Guatemala, February 21, 1916 (510A); February 25, 1916 (530).

It is a lepto-form with telia in orbicular groups 1-4 mm. across. The spores are oblong or lanceolate oblong, 15-17 by 39-50 μ , acute or obtuse at apex, obtuse or narrowed at base, and scarcely constricted at the septum. The wall is smooth, chestnut brown, rather thin, 1-2 μ and considerably thickened to 7-9 μ at apex. The pedicel is firm, colored like the spore, about one-half the spore length.

The type of *P. Elephantopodis-spicati* Pat. was described from material collected by *Tonduz* at San Francisco de Guadalupe, Costa Rica, July 1908. A portion of the type has been examined and agrees in all essential features with the type of *P. paupercula* and occurs on the same host species.

27. PUCCINIA ELEPHANTOPODIS P. Henn. Hedwigia Beibl. 39:154. 1900.

This species, known only from the type collection made at Santa Anna, Argentina, by *G. Neiderlein*, January 22, 1883, on *Elephantopus angustifolius*, is interpreted by SYDOW as being a micro-form. He states that the urediniospores described by HENNINGS are single cells of the teliospores. The latter are described as ovoid, subcuneate to ellipsoid, 18-23 by 25-33 μ , wall minutely verrucose, 3-4 μ thick, light brown, apex not or scarcely thickened, constricted at the septum, pedicel hyaline, short, fragile. This species has not been seen by the writer, and the assignment in the preceding key is largely based on SYDOW's interpretation.

28. PUCCINIA PIPTOCARPHAE P. Henn. Hedwigia 35:240. 1896.

This species was described from two specimens collected at St. Catharina, pr. Blumenau, Brazil, by *E. Ule*, one on *Piptocarpha oblonga*, the other on *Piptocarpha* sp., December 1888, nos. 1317, 1198. Specimens of both collections have been examined by the writer. The urediniospores are globoid, 27-32 by 29-34 μ , wall cinnamon brown, 1.5-2.5 μ in thickness, moderately and strongly echinulate, the pores obscure but apparently 4-6, scattered. The teliospores are oblong clavate or ellipsoid, 26-29 by 45-56 μ , apex and base rounded, somewhat constricted, wall cinnamon brown, 1 μ or less in thickness, smooth; wall slightly thickened to 2.5 μ at apex.

29. PUCCINIA LEPTODERMA Diet. Hedwigia 38:251. 1899.

While evidently related to the preceding species, the form differs markedly in the width of the teliospores, which are described as ellipsoid to oblong, 28-35 by 45-60 μ , constricted at septum, but not thickened at apex. No uredinia or urediniospores are described. This species has not been seen by the writer. It was reported on *Piptocarpha* sp. from Maná, Rio de Janeiro, Brazil, August 1896, *E. Ule* (2334).

EXCLUDED SPECIES

PUCCINIA VERNONIAE Cke. Grevillea 10:26. 1882.

This species has not been seen. It was based on several collections made in Natal by *Wood*. The teliospores are evidently immature, as stated by *COOKE* in the original description and reaffirmed by *SYDOW* (*Monographia Uredinearum* 1:178. 1902), who has apparently examined an original specimen. In any case the name is untenable (cf. 13). It seems best, therefore, to disregard this species in the present account.

HOST INDEX

Elephantopus	<i>Vernonia (continued)</i>	<i>Vernonia (continued)</i>
angustifolius 27	Deppeana 22	mollissima 14
spicatus 26	divaricata 1, 7	noveboracensis 13
Piptocarpha	Drummondii 13	patens 21, 23
oblonga 28	Ervendbergii 13	phyllostachya 4
sp. 28, 29	fasciculata 13	platensis 24
Vernonia	flexuosa 11	pluvialis 8
Alamani 15	gigantea 13	pulchella 13
albicaulis 4, 7	guadalupensis 13	sericea 4
altissima 13	interior 13	scabra 21
arbuscula 4	Karwenskiana 15	scariosa 10
bahamensis 4	Kuntzii 25	Schiedeanã 3
Baldwinii 13	leiocarpa 16, 18	scorpioides 14
borinquensis 4	longifolia 7, 12	Shannoni 18
canescens 4	Lorenzii 14	triflosculosa 17, 20
cauloni 2	maxima 13	Tweediana 21
crinita 13	menthaefolia 12	umbellifera 15
crotoneaster 1	missourica 13	uniflora 19
	mollis 6	sp. 5, 7, 9, 13, 15, 21